Listeria monocytogenes infections in Canada*

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Summary: Between 1951 and January 1972 listeriosis was diagnosed bacteriologically in 101 Canadian patients. This study adds 80 cases to the 21 reported from Metropolitan Toronto by Sepp and Roy in 1963. The Laboratory Centre for Disease Control, Ottawa, collated epidemiological and clinical data. Serotypes of *Listeria monocytogenes* included 4b (53), 1 (15), 1b (6), 1a (2), 2 and 3. Clinically, 54 patients had meningitis and 23 septicemia. The mortality rate was 30%.

Between 1954 and January 1972 listeriosis affected 15 British Columbian patients: nine were male and six female; 12 were less than 1 or more than 45 years old. Among the patients were a pregnant mother and the son to whom she gave premature birth. A day-old infant and an elderly man died.

Résumé: *Les infections à* Listeria monocytogenes *au Canada.*

De 1951 à janvier 1972, on a posé un diagnostic bactériologique de listériose chez 101 canadiens. La présente étude ajoute 80 cas aux 21 cas déjà signalés par Sepp et Roy en 1963 dans la région du Toronto métropolitain. Le "Laboratory Centre for Disease Control" d'Ottawa a colligé les données cliniques et épidémiologiques. Parmi les sérotypes de *Listeria monocytogenes* relevés, on notait les types 4b (53), 1 (15), 1b (6), 1a (2), 2 et 3. Sur le plan clinique, on comptait 54 cas de méningite et 23 de septicémie. La mortalité atteignait 30%.

De 1954 à janvier 1972, une listériose confirmée touchait 15 malades de Colombie britannique, dont neuf malades de sexe masculin et six de sexe féminin. L'âge de 12 malades variait de moins d'un an à plus de 45 ans. Parmi les malades, il y avait une femme enceinte et son enfant, né prématuré. Un nourrisson d'un jour et un homme âgé sont morts.

Since Murray, Webb and Swann[1] completed their classical study of an epidemic in laboratory rabbits in 1926, *Listeria monocytogenes* (LM) has slowly come to be recognized as a significant pathogen, not only of wild and domestic animals[2] but also of man.[3] This diphtheroid bacillus was isolated in Europe,[1-5] Australia[6] and South Africa.[7] In 1918 Dumont and Cotoni[5] reported the first authentic isolate of LM from man. In 1933 LM was implicated in perinatal infection.[8] In 1940 Paterson[9] found that all his strains of LM from animals and man fell into four serological types. By 1963, when Sepp and Roy[10] made their report on listeriosis in Ontario, LM had been recovered from patients with a wide variety of syndromes, including meningitis,[11-14] other central nervous system involvement,[15] infectious mononucleosis-like disease,[11,16] septicemia,[17] purulent rhinitis,[18] habitual abortion and genital

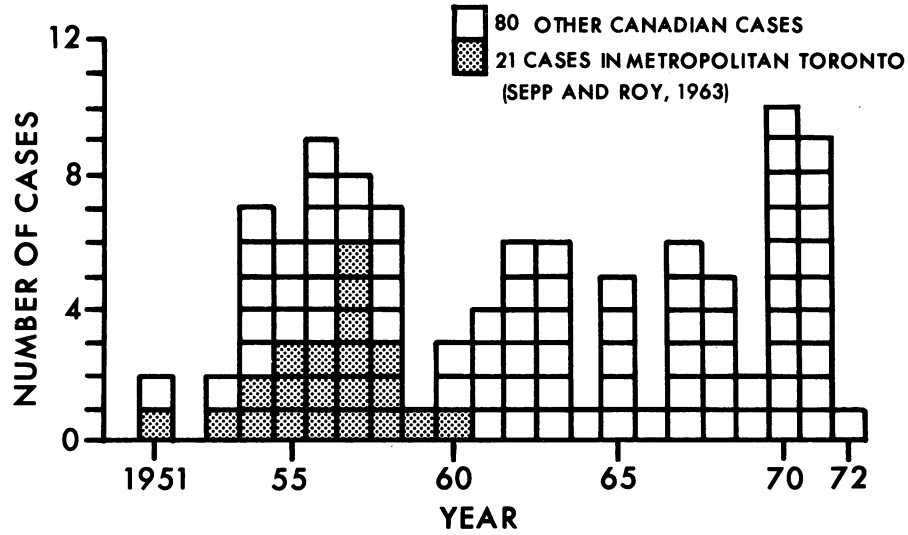

FIG. 1 — 101 cases of listeriosis in Canada, 1951 to January 1972, by year of onset.

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Table I — Summary of findings in 80 of 101* patients with confirmed listeric infection, Canada 1951 — January 1972

Year	LCDC patient no.	Province**	Age	Sex	Source of LM: Blood	CSF	Nose/Throat	Uterus/Vagina	PM brain/lung	Type	Symptomatology: Meningitis	Rash	Coryza/Fever/URI	Pneumonia	Septicemia	Therapy***	Recovered	Died	Remarks	Reference no.
1951	1	Ont	24 yr	F				+		4b			+				+		Pregnant (mother of Sepp & Roy case 1)	19
1953	4	Ont	Adult	M	+						+						+			28
1954	6	NS	14 yr	M		+					+					C, P, S, St	+			29
"	7	NS	63 yr	F	+										+	P, T		+		29
"	8	Ont	Adult	F				+		4b							+		Pregnant (mother of Sepp & Roy case 2, infant infected with LM died as newborn)	30
"	*9*	*BC*	*53 yr*	M		+				3	+					P, S, St	+			
"	10	Ont	Adult	F				+		1			+			P, St	+		Pregnant (mother of Sepp & Roy case 3, infant infected with LM died at 3 hrs)	30
1955	12	NS	7 mo	M		+					+					P, S, St, T	+			29
"	13	Ont	1 da	?	+	+									+					
"	17	NS	14 da	F	+	+				4b	+	+		+		Antibiotics	+		Premature, 5 lb. 8 oz.	31
1956	18	NS	14 da	M		+				4b	+					P, T		+	Premature, 51b. 14 oz.	31
"	19	NS	1 da	M		+				4b	+	+				C, P		+	Premature, 31b. 12 oz. died on 19th day	31
"	20	NS	14 da	M		+				4b	+	+				P, S		+		31
"	21	Nfld	7 da	F		+					+			+		C, cort, P, S, St		+		32, 33
"	22	Que	14 da	M		+			+	1	+	+		+				+		
"	26	Ont	24 yr	F				+								Antibiotics	+		Pregnant (mother of Sepp & Roy case 5, infant infected with LM died on 2nd day)	34
1957	27	Que	21 da	?		+				4b	+			+		Antibiotics	+			
"	28	Ont	15 da	M							+						+			
1958	38	Ont	1½ yr	F			+			4b			+			Antibiotics	+			
"	39	Que	10 da	?																
"	40	Que	Adult	F				+									+			
"	41	Que	28 da	M		+					+					C, P, S		+	Hydrocephalus, died later in infancy	
1960	43	Sask	?	F	+					1							+			
"	78	Nfld	10 da	?							+							+		33
1961	45	Ont	2 mo	M		+			+		+					C	+		Mother had mild toxemia; baby unwell at birth, hydrocephalus at 7 wks, deadl ater	
"	46	Ont	65 yr	F		+				4b	+					C, cort, P		+		35
"	47	Ont	2 mo	M		+				4b	+					C, S, T		+	Hydrocephalus	
"	*48*	*BC*	*28 da*	F		+				4b	+					C, E, P	+			
1962	*67*	*BC*	*6 mo*	M		+				4b	+					C, P, S	+			
"	49	Ont	54 yr	M	+					4b					+	P, St	+		Initial diagnosis endo-carditis	
"	50	Que	21 da	F		+				1	+					C, P, St				
"	51	Sask	10 da	M		+				4b	+					C, P, S	+		Meningitis 2-3 wks after birth	
"	52	Ont	57 yr	F		+				4b	+									
"?	101	Ont	52 yr	F		+					+		+			C, P, St	+		No antibodies demonstrated	36
1963	53	Nfld	1 mo	M		+				4b	+	+				C, P, S, St, T		+	Mother LM titre 1:160; father LM titre 1:40; 10 days before infant fell ill two frozen hares (brought from New Brunswick) were skinned at home, cooked and eaten	
"	54	NB	21 da	F		+				4b	+					C, P	+			
"	55	Ont	62 yr	M		+				1	+					C, P	+			
"	56	Ont	34 yr	F				+		1			+				+		Abortion at 18 wks; normal child one yr later	
"	57	Nfld	49 yr	M						4b	+					P, St, T		+	Heavy drinker for yrs	
"	58	Nfld	?	?						1										

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Year	LCDC patient no.	Province**	Age	Sex	Source of LM: Blood	CSF	Nose/Throat	Uterus/Vagina	PM brain/lung	Type	Symptomatology: Meningitis	Rash	Coryza/Fever/URI	Pneumonia	Septicemia	Therapy***	Recovered	Died	Remarks	Reference no.
1964	59	Ont	2 da	F	+	+					+	+			+	C, P	+		Mother had toxemia; one year previously mother had stillbirth	
1965	*60*	*BC*	*1 da*	M	+		+								+	P	+		Premature birth; son of case #61	
"	*61*	*BC*	*Adult*	F				+					+			P	+		Pregnant; mother of case #60	
"	*62*	*BC*	*3 da*	F		+					+					K, P	+		Twin cesarean births; other twin normal	
"	63	Ont	22 yr	F	+			+		4b							+		Abortion at 16 wks	
"	70	Ont	?	?	+					4b										
1966	*64*	*BC*	*1 da*	M					+	4b				+	+			+	Premature birth; mother LM titre 1:50	
1967	*65*	*BC*	*78 yr*	F		+				4b	+					P	+			
"	66	Ont	69 yr	F	+			+		4b	+				+			+	Coma and hyperpyrexia	
"	69	Ont	?	?						4b										
"	71	NS	?	?																
"	72	NS	?	?																
"	73	NS	?	?																
1968	*68*	*BC*	*1 mo*	M		+				4b	+					A, C, P, S	+			
"	74	Man	67 yr	F		+					+					T, C, A, St, P	+		Some permanent disability	37
"	75	Ont	38 yr	M	+					4b					+	P	+			
"	76	Man	66 yr	F												A, P, T		+		
"	77	Ont	11 da	M	+					1					+	A, K	+			
1969	79	Alta	37 yr	M		+				1	+	+				A, S	+			
"	81	Alta	52 yr	M		+				1	+					S, P, C	+			
1970	*80*	*BC*	*77 yr*	M		+				1	+					P, C	+			
"	82	Ont	45 yr	M	+	+				4b	+					A, P, S, St		+		
"	83	Que	1 da	M			+			1					+	A	+			
"	84	Ont	3 yr	M	+	+				4b	+	+				A, K	+			
"	85	Ont	73 yr	M		+				1	+					P, Ceph	+			
"	86	Ont	1 da	F			+			4b					+	A, K	+			
"	87	Ont	10 da	F		+				1	+					A, K	+			
"	88	Ont	?							4b										
"	89	Ont	10 da	M		+				4b	+					P, K, A	+			
"	90	Ont	47 yr	M						Ib									Arm of veterinarian infected from bovine uterus	
1971	91	Ont	60 yr	M	+	+				1a	+					A, G		+		
"	92	Ont	65 yr	M	+					1b					+	A	+		Carcinoma of lung	
"	93	Ont	1 da	F	+		+			4b	+					A, K	+			
"	94	Ont	5 wk	M		+				4b	+					A, K	+			
"	*95*	*BC*	*46 yr*	F		+				1b						P	+		Chronic alcoholic; some permanent disability	
"	*96*	*BC*	*76 yr*	M	+					1b								+	Autoimmune radiculitis and hemolytic anemia	
"	97	NB	2 wk	F			+			4b	+					A	+			
"	*98*	*BC*	*74 yr*	M		+				1b	+					A	+			
"	*99*	*BC*	*2 yr*	F		+				1b	+					P, A	+			
1972	*100*	*BC*	*45 yr*	M	+					1a					+	P	+		Two kidney transplants rejected	

* 21 patients of Sepp and Roy[10] not listed
LCDC patients' nos. 2 3 5 24 25 29 30 35 36 42 44 14 16 31 32 37 11 15 23 33 34
Sepp and Roy[10] nos. 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21
**For full names of provinces see Table II.
***A — ampicillin, C — chloramphenicol, Ceph — cephaloridine, cort — cortisone, E — erythromycin, G — gentamicin, K — kanamycin, P — penicillin, S — sulpha, St — streptomycin, T — tetracycline

infection,[19-21] and perinatal disease,[22-24] as well as from healthy carriers.[25] Further information may be obtained from reviews in Canada,[26,27] the United States[2] and Germany.[17] The present report brings the Canadian record of human listeriosis up to date, describes cases reported from British Columbia, and advocates more adequate documentation of listeric incidents.

Human listeriosis in Canada

In 1951 Stoot[19] isolated the first confirmed strain of LM from a human source in Canada. Between 1951 and January 1972, in laboratories across Canada, strains of LM were recovered

Table II — Geographical distribution of 101* strains of LM from human infections, Canada 1951 — January 1972, by serotype

Province	Serotypes								
	1	1a	1b	2	3	4b	Total	Not typed	Total strains
New Brunswick						2	2		2
Nova Scotia						4	4	6	10
Newfoundland	1					2	3	2	5
Quebec	3					1	4	3	7
Ontario	7	1	2	1		38	49	7	56
Manitoba								2	2
Saskatchewan	1					1	2		2
Alberta	2						2		2
British Columbia	1	1	4		1	5	12	3	15
Total	15	2	6	1	1	53	78	23	101*

*Includes 21 patients reported by Sepp and Roy[10]

Table III — Clinical features in 82* cases of bacteriologically confirmed listeric infection, Canada 1951 — January 1972, by age

Age group	No. of patients	Clinical features		
		Meningitis	Septicemia	Other syndromes
Birth to 24 hr	4	0	4	0
1 to 28 da	34	22	12**	0
1 to 12 mo	9	9	0	0
1 to 44 yr	12	6	3	3
45 or more yr	23	17	4	2
Total	82	54	23	5

*Insufficient information available on 19 cases; includes 21 cases reported by Sepp and Roy[10]
**Includes one patient with meningitis

Table IV — Case mortality rate in 85* cases of bacteriologically confirmed listeric infection, Canada 1951 — January 1972, by age and sex

Age group		Cases				Total		Case mortality %
		Male		Female				
		No.	Died	No.	Died	No.	Died	
Birth to 24 hr		2	2	2	2**	4	4	100
1 to 28 da		15	7	15	6	30	13	43
1 to 12 mo		8	2	1	0	9	2	22
1 to 44 yr		6	0	12	0	18	0	0
45 or more yr		17	6	7	4	24	10	42
Total	Cases	48	17	38	12	85	29	—
	% Mortality	35		32		34		

*Insufficient information available on 16 cases; includes 21 cases reported by Sepp and Roy[10]
**Includes one stillbirth

from 101 persons (Fig. 1). Records of listeric infections, maintained at the Laboratory Centre for Disease Control (LCDC, formerly Laboratory of Hygiene), Ottawa, are reproduced in Table I.[19,28-37] Excluded from Table I are the 21 cases from Metropolitan Toronto between 1951 and January 1960 reviewed by Sepp and Roy[10] in 1963. In the present series the laboratory and clinical findings on a further 80 patients with listeric infection are added to the Canadian record. For easy reference we have used the LCDC patient numbers. In preparing Tables II, III and IV we have incorporated relevant data on all 101 Canadian patients.

Geographical distribution

The 101 cases of listeriosis recorded during this 21-year period were distributed in nine of Canada's ten provinces (Table II); more than half (55%) occurred in Ontario.

In only 31 patients was the place of residence accurately recorded: 21 patients lived in urban surroundings, 10 in rural.

Clinical features

Of the many clinical types of listeriosis, septicemia is most common in infants, meningitis in older children and adults of 45 years or more. Clinical features of 82 of the 101 confirmed cases are shown in Table III.

The 21 cases described by Sepp and Roy[10] comprised three clinical groups: 11 patients had listeriosis of the newborn (granulomatosis infantiseptica); eight, listeriosis of the central nervous system; and two, high fever, upper respiratory tract infection and irritability. In only 64 of our 80 cases was symptomatology recorded: 48 had meningitis, 11 septicemia, and five fever, coryza or respiratory infection.

Skin lesions: Rashes and purpura occurred in 12 infants: six had septicemia and six meningitis; 10 died. Hence the development of skin lesions suggests poor prognosis.

Mortality: In Sepp and Roy's series[10] the mortality rate was 91% in listeriosis of the newborn and 25% in listeriosis of the central nervous system. In our series the mortality rate was 32% in patients with meningitis and 36% in those with septicemia. Of the 101 patients, 30 died of listeriosis: 20 were less than 1 year and 10 more than 45 years old (Table IV). The ages of the infants ranged from stillborn at the 30th week of pregnancy to 2 months; 11 were male and eight female (one not recorded). The ages of the adults ranged from 45 to 76 years; six were men and four women.

Materials and methods

Type cultures

The late Dr. M. L. Gray, Montana State College, Bozeman, Montana, U.S.A., kindly provided type cultures in 1961.

Dr. Wallis Jones, Chief, Bacterial Immunology Unit, Center for Disease Control, United States Public Health Service, Atlanta, Georgia, kindly provided cultures of LM type 1a and type 1b.

Identification

When each strain of LM was received at LCDC for confirmation and serotyping, the culture was inoculated into two tubes of semisolid agar and two tubes of tryptose phosphate broth. One agar and one broth culture were incubated at 22°C. and the others at 37°C. Motility of organisms was checked by darkfield microscopy of broth cultures. Ability of the strain to grow at 4°C. in tryptose phosphate broth was also tested.

Preparation of antigens

For use in serotyping, O and H antigens were prepared from each new strain of LM.

O antigen: After incubation on 1% dextrose tryptose agar at 37°C. for 24 hours, the culture was suspended

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in buffered physiological saline at pH 7.2, filtered through glass wool and autoclaved for 45 minutes. The suspension was washed three times and re-suspended in 1:10,000 merthiolate. Agglutinability of some strains was improved by trypsinization.

H antigen: The inoculum was pre-incubated at 22°C. for 24 hours in 1% dextrose tryptose phosphate broth at pH 7.2. By means of a dropper, this inoculum was seeded onto the moist surface of plates containing 1.5% agar with 1% dextrose and phosphate buffer. After incubation at room temperature for 72 hours the culture was suspended in 0.3% formol-saline and incubated at 37°C. for 24 hours. Clumps of bacteria were discarded.

Production of antisera

Antisera were prepared by intravenous immunization of rabbits at intervals of four days for three to four weeks. The initial inoculum was 0.5 ml. of a suspension with the opacity of tube No. 6 of the McFarland nephelometer. The second and third injections were 1 ml. and the remainder were 1.5 ml. When a test bleeding indicated satisfactory antibody titre, the rabbit was exsanguinated.

Serological techniques

The techniques used for agglutinin absorption and for tube agglutination tests were those described by Seeliger.[17]

Bacteriological findings

The source of LM was recorded for 120 isolates from 89 patients: cerebrospinal fluid, 52; blood, 31; uterus or vagina, 15; upper respiratory tract, 13; unidentified postmortem specimens, 7; stool, 2; and abscess on arm, 1. The types responsible for infection and their geographical distribution in Canada are recorded in Table II. There appears to be no relation between infecting type and geographical location. LM type 3 was isolated in British Columbia in 1954 from patient #9. This uncommon type had previously been isolated, only in the United States and Denmark, from man, sheep and pigs. No strains of LM type 4a have so far been identified in Canada.

Listeriosis in British Columbia

Between 1954 and January 1972 listeric infection was confirmed bacteriologically in 15 British Columbian patients: nine were male and six female; 12 were either less than 1 year or more than 45 years old. The patients included a pregnant mother and the son to whom she gave premature birth. Clinically 10 patients had meningitis, four had septicemia, and the pregnant woman had an influenza-like illness. A 1-day-old infant and an elderly man died.

Case reports (Table I)

#9. In 1954 this 53-year-old store clerk had chills, fever and diarrhea for five days followed by headache, vomiting and stiff neck; his temperature rose to 38.9°C. Cerebrospinal fluid (CSF) contained 55 leukocytes per c. mm. with 90% lymphocytes; a day later the leukocyte count rose to 100 cells per c. mm. LM type 3 was isolated from both specimens of CSF. After five days of treatment with penicillin, streptomycin and sulfonamide, the patient became afebrile and recovered.

#48. In May 1961 this 2-week-old female infant was admitted to hospital with irritability, stiff neck, fever and drowsiness. The CSF contained gram-positive rods and 1600 leukocytes per c. mm. with 95% polymorphs. LM, later identified as type 4b, was isolated from the CSF. After a stormy course the infant's condition improved with intravenous erythromycin therapy. Penicillin and chloramphenicol were also given. Cultures of CSF taken 24 and 48 hours after the start of therapy proved sterile. Culture of two vaginal swabs from the mother failed to grow LM.

#67. In October 1962 this 6-month-old Canadian Indian boy had severe cough with fever for 10 days. He vomited once. He was given penicillin. Cultures of CSF samples collected the next day because of bulging of the anterior fontanelle yielded LM type 4b. After treatment for 10 days with penicillin, chloramphenicol and sulfonamide, the child completely recovered.

#60. When born four weeks prematurely in October 1965 this infant was obviously ill. LM was recovered from cultures of placenta and blood, and from nose and throat swabs, but not from CSF. After treatment with penicillin G for 12 days the baby made a slow but complete recovery.

#61. The mother of patient #60 was ill with chills and fever at the time of her premature delivery. Blood culture was negative, but six days after confinement culture of the lochia yielded LM. She was treated with penicillin G for 12 days and recovered quickly. Subsequent vaginal cultures failed to grow LM.

#62. In October 1965 this baby, the first and larger of twins delivered by cesarean section, became ill on the third day of life. LM was isolated from the CSF. After treatment with kanamycin and penicillin the baby's health improved rapidly. The second and smaller twin was not ill. The mother had a mild febrile illness before confinement, for which she received penicillin. LM was not recovered from a swab of the cervix taken two weeks after confinement.

#64. On November 21, 1966, 10 minutes after his premature birth, this infant, 1500 g. in weight and 39 cm. in length, suddenly developed cyanosis and respiratory distress. The infant's temperature was

35.3°C. and his spleen was palpable. Treatment included intubation, airway suction and administration of oxygen. On November 22 his respiration became laboured and gasping and the rate rose to 90 per minute. Sclerema neonatorum and slight jaundice appeared. Despite fluids given intravenously and oxygen (45% atmosphere), the infant's condition continued to deteriorate. He died 33 hours after birth.

Necropsy revealed acute inflammation of the umbilical cord with narrowing of the arteries, areas of red and grey hepatization in the lungs, congestion of the spleen, small granulomas of the adrenals with central polymorphonuclear cells throughout the cortex and medulla, and early granulomas of the liver. Culture of a swab from the parenchyma of the lung yielded gram-positive, motile, non-sporing, aerobic rods, identified as LM type 4b.

The infant's 28-year-old mother had had two normal pregnancies. About two months before term in her third pregnancy she suddenly went into premature labour. After confinement her listeria antibody titre was 1:50. She remembered no recent close contact with animals but recalled buying raw milk and cream shortly before conception.

#65. In 1967 this 78-year-old woman complained of fever, lassitude and neck stiffness. On the fourth day she was confused and lapsed into coma. The leukocyte count was 8700 per c. mm. with 70% polymorphs and 15% staff cells. The CSF contained 60 leukocytes per c. mm. with 65% lymphocytes and 35% polymorphs; culture yielded LM type 4b. After receiving penicillin G intravenously for eight days the woman recovered completely.

#68. In 1968 this male infant was well after delivery by cesarean section. At four weeks he had a small umbilical granuloma which was cauterized with silver nitrate. Four days later he became pale and listless and his temperature rose to 40.0°C. Although there was no neck rigidity and the anterior fontanelle was soft, lumbar puncture was performed. The CSF was cloudy and contained 650 cells per c. mm. with 86% polymorphs and 14% lymphocytes. On culture LM was isolated. After intravenous administration of chloramphenicol, penicillin, ampicillin and gantrisin the infant completely recovered.

In India, about one year earlier, the infant's mother had given birth to a baby who died within hours. The cause of the child's death was not recorded; listeriosis cannot be excluded.

#80. In 1970 this 77-year-old retired railway labourer collapsed in a hotel room. When found, he was confused and semicomatose; he had neck rigidity. LM type 1 was recovered from the CSF. After treatment with intravenous penicillin and intramuscular chloramphenicol he slowly recovered.

#95. In 1971 this 46-year-old chronic alcoholic woman was admitted to hospital with weakness, vomiting and generalized tremor. Next day her condition deteriorated and she had a grand mal seizure followed by hemiparesis, episodic conjugate deviation of the right eye, aphasia, episodes of tremor of arms and legs, and coma. The CSF contained increased protein and culture yielded LM type 1b.

The patient was given 40 million units of penicillin daily for six weeks. After two days she recovered consciousness. CSF collected 12 days later contained normal amounts of protein and 25 lymphocytes per c. mm. Frequent seizures were eventually controlled with diazepam and diphenylhydantoin. On transfer to a rehabilitation centre the patient's residual disabilities included mild right hemiparesis, aphasia and right hemianopsia.

#96. From 1968 this 76-year-old man was maintained on steroid therapy after making a dramatic recovery from autoimmune radiculitis. In 1971 he developed autoimmune hemolytic anemia which failed to improve with increased steroid therapy. He subsequently developed subacute bacterial endocarditis. Chest x-ray showed pulmonary infiltration. On six occasions blood culture yielded LM type 1b. The patient died of myocardial infarction.

#98. This 74-year-old man with chronic uveitis and glaucoma developed meningitis in 1971. LM type 1b was recovered from the CSF. After treatment with ampicillin (500 mg. 4 times daily for seven days) he slowly recovered.

#99. In 1971 LM type 1b was isolated from the CSF of this 2-year-old girl. After treatment with penicillin and ampicillin she recovered quickly.

#100. After rejection of two renal transplants this 45-year-old man was maintained on hemodialysis for two years. While recuperating from surgical revision of his arteriovenous shunt in 1972 he developed sore throat, earache and spiking fever. Blood culture yielded LM type 1a. After treatment with penicillin G he recovered. Australia antigen was found in his blood.

Discussion

Reservoirs and transmission

The host range of LM is astonishingly wide, including at least 37 mammals in addition to man, 17 fowls, ticks, fish, crustaceans, and a fly caught in a laboratory. LM has been found in stream water, mud, sewage, slaughter house waste, silage and sickroom dust.[2] It remains viable in dust and dirt, even after prolonged exposure to sunlight;[17,38] it can survive in damp soil for up to 295 days.[39]

Asymptomatic human and animal carriers of LM probably play a primary role in perpetuating and transmitting listeriosis.[25] LM has been cultured from blood and urine and from swabs of ear, nose and genitalia of asymptomatic persons.[25] Although the exact mode of transmission is seldom discovered, the routes are ingestion, direct contact or inhalation. Ingestion of foods of animal origin, such as unpasteurized milk products[11] and intravitally infected poultry, meat and game,[17] commonly transmits LM to man. On one occasion LM appeared to be transmitted from contaminated human feces to soil, to fresh vegetables and thence, by ingestion, to man.[2] Certainly culture of feces from workers in food packing-houses yields LM more often than culture of feces from members of the general population, which suggests an occupational hazard. Often direct contact is the mode of spread: listeric lesions may arise on the arms of farmers and veterinarians after delivering infected livestock; the offspring of infected women may acquire infection in the uterus or in the birth canal;[25,40] and infection may also be transmitted sexually. Infection by inhalation, more difficult to prove, was the probable method of spread[17] when a Norwegian farmer contracted pneumonia and died of meningitis shortly after sweeping out his sheep stable. LM was recovered in cultures of pus from the patient's lung and of dust from the stable. This farmer probably acquired his fatal infection by inhaling LM in dried sheep feces.

Although animal contact is seldom clearly documented, clusters of cases have been associated either with drinking unpasteurized milk or with tending animals subsequently found to have listeric infection. Nevertheless, other modes of transmission are probably more common.

Incidence in man

Listeriosis is more common than generally suspected. Its prevalence tends to be proportional to the physician's index of clinical suspicion and to the bacteriologist's ability to recognize the organism.[2] Occurring at all seasons, listeriosis afflicts persons of all ages and both sexes, but particularly the very young and the elderly.

Clinical features

The clinical picture depends on the age of the patient and the mode of infection. Clinical forms of listeric infection distinguished by Seeliger[17] include: (a) septicemia (with angina of the throat and mononucleosis), (b) oculoglandular fever, (c) cervicoglandular fever, (d) meningitis or meningoencephalitis, (e) granulomatosis septica and typhoid-like pneumonia, (f) granulomatosis infantiseptica of the newborn, (g) listeric infection during pregnancy, (h) cutaneous listeriosis, and (i) other forms including chronic urethritis (sometimes mixed infections with gonorrhea), upper respiratory infection and opportunistic infections in patients with debilitating disease. The syndrome most often recorded in North America is meningitis and in Europe septicemia.

Yet listeriosis is not necessarily an

acute, highly fatal disease; it may be low-grade or even inapparent, clinically significant only in pregnancy, when maternal infection may lead to abortion, stillbirth or premature birth.[20,25] Up to 70% of women who repeatedly abort may suffer from inapparent listeric infection.[3] Infants of infected mothers may be born with septicemia or develop listeric meningitis in the neonatal period. After giving birth to an infected infant the mother may shed LM in vaginal exudate or urine for up to 10 days. Listeriosis ranks with erythroblastosis fetalis, syphilis, toxoplasmosis and rubella among the major causes of fetal damage and neonatal death.[17]

Laboratory identification

LM is a small, uniformly staining, gram-positive, rod-shaped bacterium with peculiar tumbling motility at room temperature but not at 37°C.; it shows hemolysis on blood agar; and it may be mistaken for diphtheroids or streptococci. Any organism with these characteristics isolated from blood, cerebrospinal fluid, amniotic fluid or urine, or from swabs of throat, ear or vagina should be tested for motility at room temperature since it is almost certain to be LM.[41] Simply by examining hanging-drop preparations and gram-stained smears the presumptive diagnosis of listeriosis is often apparent. All strains should be typed.

Serological diagnosis

Since listeric agglutinins are demonstrated in sera from many who have never had overt infection, diagnosis based solely on serological tests is inconclusive. Moreover, not all proved listeric infections lead to the production of specific antibodies. Even titres of 1:240 to 1:480 are of doubtful significance; the antigens and the technique of the test are critical. Ideally, paired acute and convalescent sera should be examined at the same time for O and H antibodies. Mothers of infants with neonatal listeriosis usually show increase in antibodies; a titre of 1:320 is then considered significant.

Treatment

LM is sensitive to many antibiotics. The drugs of choice are penicillin and ampicillin, with tetracycline and erythromycin as alternatives. Early administration of antibiotics significantly decreases the mortality of listeric infections. Administration of cortisone or its derivatives may cause asymptomatic listeric infection to become overt.

Control

Whenever a woman aborts or bears a child prematurely she should be asked whether she suffered from an influenza-like disease during her pregnancy; this is a common feature of listeriosis. As a precaution, pregnant women should avoid handling sick animals and consuming unpasteurized dairy products. The mother who bears a listeric child need not, however, fear a subsequent pregnancy. Her family physician, fully aware of potential hazards, will ensure that blood and vaginal exudate are cultured and serological tests are performed.

Lack of accurate epidemiological information on listeriosis hampers prevention and control. To obtain comprehensive records, reporting of human and animal infections should be mandatory. With increased familiarity the recorded incidence of listeric infection will undoubtedly increase. Medical and veterinary health agencies must exchange information and coordinate their control measures. Farmers and veterinarians should adopt sound sanitary practices in handling sick or aborting domestic animals and livestock. Improved measures for preventing and controlling human listeriosis depend on increasing awareness of its diverse clinical manifestations and an increasing index of suspicion.

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